Do dispatcher instructions facilitate bystander-initiated cardiopulmonary resuscitation and improve outcomes in patients with out-of-hospital cardiac arrest? A comparison of family and non-family bystanders

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Do dispatcher instructions facilitate bystander-initiated cardiopulmonary resuscitation and improve outcomes in patients with out-of-hospital cardiac arrest? : A comparison of family and non-family bystanders

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Abstract

Objectives: Bystander-initiated cardiopulmonary resuscitation (CPR) has been reported to increase the possibility of survival in patients with out-of-hospital cardiopulmonary arrest (OHCA). We evaluated the effects of CPR instructions by emergency medical dispatchers on the frequency of bystander CPR and outcomes, and whether these effects differed between family and non-family bystanders.

Methods: We conducted a retrospective cohort study, using Utstein-style records of OHCA taken in a rural area of Japan between January 2004 and December 2009.

Results: Of the 559 patients with non-traumatic OHCA witnessed by laypeople, 231 (41.3%) were given bystander CPR. More OHCA patients received resuscitation when the OHCA was witnessed by non-family bystanders than when it was witnessed by family members (61.4% vs. 34.2%). The patients with non-family-witnessed OHCA were more likely to be given conventional CPR (chest compression plus rescue breathing) or defibrillation with an AED than were those with family-witnessed OHCA. Dispatcher

instructions significantly increased the provision of bystander CPR regardless of who the witnesses were. Neurologically favorable survival was increased by CPR in non-family-witnessed, but not in family-witnessed, OHCA patients. No difference in survival rate was observed between the cases provided with dispatcher instructions and those not provided with the instructions.

Conclusions: Dispatcher instructions increased the frequency of bystander CPR, but did not improve the rate of neurologically favorable survival in patients with witnessed OHCA. Efforts to enhance the frequency and quality of resuscitation, especially by family members, are required for dispatcher-assisted CPR.

Keywords

cardiopulmonary resuscitation; out-of-hospital cardiopulmonary arrest; bystander resuscitation; dispatcher instruction

Introduction

The validity of rapid initiation of cardiopulmonary resuscitation (CPR) in rescue of patients with out-of-hospital cardiopulmonary arrest (OHCA) has been widely reported.[1-5] Early basic life support (BLS) can be more effective than early advanced cardiac life support by physicians because the time intervals from emergency call to emergency medical services (EMS) arrival and from emergency call to arrival in hospital are becoming longer year by year in Japan.[6] Bystander-initiated CPR has been reported to increase the possibility of neurologically favorable survival in many communities.[3,4,6] Therefore, laypeople are expected to initiate CPR promptly before EMS arrival. Nevertheless, in 2010 more than half of OHCA patients in Japan did not receive bystander CPR.

BLS training in offices, schools, and other public institutions is an effective educational opportunity, leading to understanding of the "chain of survival" and promotion of CPR by citizens, which has resulted in increased rates of survival from OHCA in recent years.[7] Another scheme for promoting bystander CPR is the provision of instructions in resuscitation over the telephone by the emergency medical dispatcher (dispatcher-assisted CPR).

Telephone instructions are shown to increase the frequency of bystander CPR,[8,9] as well as the chance of survival from OHCA,[9,10] although the beneficial effect on survival is still controversial.[11] CPR instructions by dispatchers involve several problems: dispatchers have difficulties in identifying OHCA and giving appropriate CPR instructions because of limited (voice-only) information, and protocols for dispatcher instructions are not established, leading to differences in the quality of dispatcher-assisted CPR among local EMS. The various backgrounds of bystanders, including age, relationship with the OHCA patient, and experience of BLS training, are speculated to make it difficult for dispatchers to give adequate instructions. Several studies investigated the influence of bystander background on CPR provision and on survival from OHCA.[12,13] However, the findings from these studies are insufficient to evaluate the relationship between bystander background and dispatcher-assisted CPR.

In Japan, the Fire and Disaster Management Agency has been collecting Utstein-style OHCA records[14] from all over the country and announcing the results of nationwide surveys since 2005.[6] Some advanced regional EMS had already started to analyze the records from their areas of control before that

year. In this study, we examined the Utstein-style records from such an area to determine whether CPR instructions by dispatchers have a beneficial effect on the provision of bystander CPR and, ultimately, on the improvement in outcomes of OHCA patients.

Methods

Study Design, Population, and Setting

The investigation was a retrospective cohort study using Utstein-style records[14] from the northern region of Ibaraki prefecture, Japan, collected from January 1, 2004 through December 31, 2009. Covering an area of 1015 km^2, this part of the prefecture consists of 4 cities and 1 village and has approximately 370,000 inhabitants. It is a relatively rural area with geographical variation from coastal to mountainous areas. Its medical resources are poor because of a shortage of medical professionals and no hospitals offering advanced, lifesaving emergency care.

The Utstein-style records included those of patients with OHCA who were provided CPR by the EMS and taken to hospital. All OHCA cases were

inspected and confirmed by the Northern Ibaraki Medical Control Council, which controls and supports EMS activities in this area. The present study focused on a subset of non-traumatic OHCA patients; that is, any traumatic OHCA such as those caused by a traffic accident, asphyxia, drowning, drugs, or fire were excluded. We included cases of non-traumatic and non-cardiac origin, as well as of cardiac origin, for the data analysis, because emergency dispatchers cannot distinguish the origin of the arrest at the time of the emergency call.

EMS System

The region we studied is served by a standard Japanese EMS system, which is activated by dialling 119 to the local fire department. In response to the call, an EMS team consisting of 3 ambulance crews is dispatched from the nearest fire station to deliver emergency care to the OHCA patient. Emergency personnel provide CPR according to a protocol developed by the local medical control council on the basis of the guidelines of the American Heart Association.[15,16] In recent years, at least 1 emergency life-saving

technician (ELT) is required to be one of the EMS team staff. ELTs are allowed to place a supraglottic airway and an intravenous line and to use semiautomated external defibrillators to rescue OHCA patients, and specially trained ELTs have been authorized to insert a tracheal tube since 2004 and to administer epinephrine since 2006. But not all EMS teams actually include an ELT under present conditions. The availability of physician-staffed ambulances is also limited; 3.6% of the cases were treated by physicians on board in the setting we have studied.

Upon receiving an emergency call, if the medical emergency dispatcher at the fire department recognizes the patient as being in cardiopulmonary arrest, he or she gives resuscitation instructions to the caller according to the local triage protocol. Some citizens have been trained in resuscitation procedures mainly at school, the office, or at public events. Automated external defibrillator (AED) use by citizens has been approved in Japan since July 2004, and the number of publicly accessible AEDs is increasing every year. However, the actual ability of citizens to provide effective resuscitation is uncertain.

Data Analysis and Statistics

Among the cumulative non-traumatic OHCA cases recorded over 6 years, we extracted those witnessed by citizens before EMS arrival (559 of 1719 cases, 33%). In only 3 of the cases were the patients younger than 15 years; these 3 cases were included in the analysis. Citizen witnesses included family members, friends, colleagues, passersby, and others, and these were divided into family and non-family bystanders. No information was obtained about how dispatcher instructions for CPR were provided to the caller in each case; therefore, only presence or absence of information was used for the analysis of dispatcher instructions. Provision of bystander CPR was defined as provision of chest compression and/or rescue breaths. Duplication of the AED attempt with another procedure was considered as an AED attempt only, because AED use has a substantial impact on patient survival, although information on whether defibrillation was actually achieved in the AED attempt was not available. Because a preliminary sampling survey indicated that witnesses and providers of bystander CPR were identical in most cases, we considered both as the same. Patient outcomes were evaluated according to the presence or absence of neurologically favorable

survival, which is defined as a score of 1 (good cerebral performance) or 2 (moderate cerebral disability) on the cerebral performance categories of the Glasgow-Pittsburg Outcome Categories[14] 1 month after the event.We used descriptive statistics to examine the characteristics, frequency and outcomes of the OHCA patients. All continuous variables were indicated as medians with interquartile ranges, and the difference in distribution between 2 groups were analyzed with the Mann-Whitney U test. For categorical variables, statistical differences were evaluated with the chi-square test or Fisher exact test in cases in which the expected number of observations was <5. Multivariate logistic regression analysis was performed to identify the predictors of provision of bystander CPR and neurologically favorable survival, including possible confounding factors related to the phase before EMS arrival, such as age, sex, bystander type, dispatcher instructions, cause of arrest, and bystander CPR. Statistical analyses were performed with SPSS Statistics version 19.0 software (IBM Japan, Tokyo, Japan).

Results

From January 1, 2004 through December 31, 2009, EMS performed resuscitation on 2037 OHCA patients, of which 1719 (84.4%) were non-traumatic. Of the 559 patients with witnessed OHCA, 414 (74.1%) were family-witnessed and 145 (25.9%) were non-family-bystander witnessed (Fig. 1).

Table 1 shows the patients' characteristics. Dispatcher instructions on emergency calls were given to approximately half the cases and did not show notable difference between the family- and non-family-witnessed cases. However, a significant difference was observed in bystander-initiated CPR, which was given more frequently to the non-family-witnessed cases. CPR procedures by bystanders also showed marked differences. In the family-witnessed cases, chest-compression-only CPR was provided much more frequently than conventional CPR, which is rescue breathing plus chest compression (68.3% vs. 28.9%), and no one was given defibrillation with an AED. In contrast, conventional and chest-compression-only CPR were given equivalently and defibrillation with an AED was attempted on 10 cases (11.2%) of the non-family-witnessed patients. Ventricular fibrillation (VF) or pulseless ventricular tachycardia (pVT), both of which are shockable

rhythms, on EMS arrival were more common and defibrillation by EMS was administered more frequently in patients with non-family-witnessed OHCA than in those with family-witnessed OHCA. The survival rate after resuscitation of patients with non-family-witnessed OHCA was also twice that of patients with family-witnessed OHCA: 10.3% vs. 5.6% for 1-month survival, 8.3% vs. 3.4% for neurologically favorable survival. The time intervals between the emergency call and professional resuscitation events did not show any differences in this study setting.

In the patients with family-witnessed OHCA, only 9.0% were provided with bystander-initiated resuscitation without dispatcher instructions, while 55.3% were resuscitated by bystanders given dispatcher instructions (Fig. 2). Similarly, dispatcher instructions increased the frequency of bystander-initiated resuscitation from 43.8% to 79.2% in non-family-witnessed cases. These effects of dispatcher instructions on the provision of bystander CPR were significant ($P<0.001$). However, the rates of neurologically favorable survival were almost the same regardless of whether the caller was given dispatcher instructions, in both the family- and the non-family-witnessed patients (Table 2).

Provision of bystander-initiated resuscitation increased the occurrence of shockable rhythm (VF or pVT) among all electrocardiograph rhythms at the first contact with the EMS, regardless of who witnessed the arrest (29.0% vs. 15.5%, $P<0.001$), which led to a higher rate of administration of professional defibrillation in patients provided with bystander CPR (33.3% vs. 20.4%, $P=0.001$). Reflecting this observation, the rate of neurologically favorable survival was 3 times higher in patients with non-family-witnessed OHCA provided with bystander CPR than in those not provided with it (11.2% vs. 3.6%, $P=0.090$; Table 2). In contrast, bystander CPR did not increase the possibility of neurologically favorable survival in patients with family-witnessed OHCA (3.5% vs. 3.3%), despite an increase in shockable rhythm.

We confirmed the above-mentioned findings on multivariate logistic regression analysis. OHCA witnessed by a non-family bystander and the presence of dispatcher instructions were strong and independent predictors of the provision of bystander CPR (adjusted odds ratio [95% CI]: 4.9 [3.0-7.9] and 9.1 [5.9-14.1], respectively) (Fig. 3A). However, they, and even the presence of bystander CPR, were not significant predictive factors of

neurologically favorable survival. Patients' age and arrest of cardiac origin were independently associated with neurologically favorable survival (adjusted odds ratio [95% CI]: 0.96 [0.94-0.98] and 8.8 [1.1-68.2], respectively) (Fig. 3B).

Discussion

We demonstrated that dispatcher instructions on emergency call facilitates bystander-initiated CPR in patients with OHCA witnessed by citizens, which is a significant change and consistent with the findings of previous studies.[8,9] The effect of dispatcher instruction was more prominent in cases witnessed by family members; resuscitation by family members was hardly expected without dispatcher instructions, but more than half of the cases received CPR with the instructions (Fig. 2). In patients with OHCA witnessed by non-family bystanders, nearly half were provided with resuscitation even when the bystanders received no instructions, which increased to approximately 80% with dispatcher instructions (Fig. 2). These results indicate the benefit of dispatcher instructions for prompting

resuscitation by citizens, despite a marked difference in frequency of bystander CPR between family- and non-family-witnessed cases. Casper and colleagues[12] reported that patients with OHCA witnessed by unknown bystanders were more likely to receive resuscitation than those witnessed by people they knew (family, friends, or coworkers). They suggested that there might be psychological barriers against performing CPR on someone one knows. Another study reported that bystanders did not perform resuscitation mainly because they panicked and were concerned about being unable to perform CPR correctly or potentially harming the patients.[13] Therefore, the closer the relationship between the patient and the bystanders is, the more these reasons might influence the performance of CPR, resulting in strong hesitation or fear in family bystanders.

Although many previous studies reported the benefit of resuscitation by laypeople in rescue of OHCA patients,[1-5] in this study we found that it was limited to arrests witnessed by non-family bystanders (Table 2). Bystander CPR showed an effect on increasing initial cardiac rhythm as VF or pVT on EMS arrival in witnessed OHCA patients. However, in the cases witnessed by family members, we could not find any difference in 1-month survival

(5.6% vs. 5.5%) and neurologically favorable survival (3.5% vs. 3.3%) between those with bystander CPR and those without. Resuscitation procedures by family members may have been insufficient, and consequently, they could not produce an eventual favorable outcome regardless of a favorable temporary effect on cardiac rhythm. In non-family-witnessed OHCAs, the neurologically favorable survival rate was higher than in family-witnessed OHCAs when provided with bystander CPR, whereas it was almost the same for the categories of witnesses when not provided with CPR (Table 2). These observations also suggest the ineffectiveness of resuscitation by family members.

It was reported that CPR was likely to be performed when OHCA occurred in a public location, was witnessed, and when the bystander was CPR-trained, younger, or not a family member.[13] Among these conditions, we do not have data on the location of the OHCA, history of CPR training, or bystander age. But it seems very possible that the OHCA witnessed by non-family bystanders occurred in public locations: offices, schools, railroad stations, public facilities, and so forth, in which relatively young people, including patients and bystanders, would happen to be present. The age of

OHCA patients is one of the critical factors in determining favorable outcome; that is, younger people are more likely to survive.[1,2,6] Although the age distributions of patients did not differ between family-witnessed and non-family-witnessed groups (Table 1), the proportion of patients aged less than 60 years (common retirement age) was larger for the non-family-witnessed cases (25.5% vs. 15.0%, P=0.004), which could account for higher survival rate in non-family-witnessed OHCAs. The age of the bystanders might also be related to the patients' outcomes, because it was shown that the quality of CPR rapidly deteriorated over time[17,18] and physical strength is required to maintain adequacy of chest compression.[19] In this respect, non-family bystanders probably had an advantage in giving more effective CPR.

Telephone instructions by dispatchers did not improve the outcome in patients with witnessed OHCA, although they did enhance the possibility of resuscitation by bystanders (Table 2, Fig. 2). As mentioned above, inadequacy of resuscitation seems to lead to this unfavorable result in family-witnessed OHCAs. Poor quality of resuscitation, however, does not explain the absence of increase in neurologically favorable survival in

non-family-witnessed cases provided with dispatcher instructions. Non-family bystanders applied resuscitation to OHCA patients much more frequently than did family bystanders without dispatcher instructions (Fig. 2), implying that the proportion of those with some history of CPR training or knowledge of resuscitation might be larger among non-family bystanders. This implication is supported by observed resuscitation procedures; non-family bystanders performed conventional CPR and attempted defibrillation with an AED more frequently than did family members (Table 1). These procedures are complicated and difficult to perform without CPR training as compared with the chest-compression-only procedure. Therefore, provision of high quality CPR, which leads to better outcome, may depend on the learning experiences of resuscitation of the bystanders rather than on the instructions given by dispatchers. A recent systematic review similarly indicated that the benefit of dispatcher instructions on hospital discharge of OHCA patients was limited and controversial, and suggested that the problem lay in the quality of CPR.[11]

In the same review, longer time intervals from collapse to CPR in the cases in which dispatcher instructions were given were suggested as one of the

factors that might counteract those benefits.[11] We also observed extended time intervals from call to CPR by EMS personnel when dispatcher instructions were provided (median of 9 min vs. 8 min, P=0.023). However, further studies are required to validate this significance in the survival outcome of OHCAs.

Limitations

This study has several limitations. First, our research cohort was small and the result regarding neurologically favorable survival was statistically underpowered. Research on larger population would be needed to confirm the present result in the future. Second, the data of some confounding factors that might have influenced the provision and quality of CPR, were not available (OHCA location, CPR training, bystander's profile, dispatcher protocol), which is potential for biases and requires careful interpretation. Finally, our discussions about the effects of the patients' age, the delays by dispatcher instructions, and the origins of arrest on bystander CPR and outcomes seem to be inadequate. Analyses by some stratification might be

needed.

Conclusion

Dispatcher instructions for CPR on emergency call were beneficial in facilitating bystander-initiated resuscitation, but not in increasing neurologically favorable survival in patients with witnessed OHCA. CPR initiated by non-family bystanders, but not by family bystanders, could increase the chance of survival. Taken together with the findings of previous studies, these results suggest that the quality of CPR might be more critical for survival than the prevalence of CPR. The quality of CPR performed by citizens could be improved by training experiences. Therefore, not only enhanced dispatcher instructions for encouraging bystander CPR but also increased opportunities for citizens to receive CPR training are needed. In addition, dispatchers are expected to focus on giving instructions for higher quality CPR especially to family members.

Conflict of interest statement

There are no conflicts of interest to declare.

Ethical approval

The study was approved by the Ethics Committee for Medical Research of the Faculty of Medicine, University of Tsukuba and conducted in compliance with Japan's Ethical Guidelines for Epidemiological Research.

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Legend for figures

Fig. 1: Flow diagram of study subject selection.

Fig. 2: Provision of bystander-initiated cardiopulmonary resuscitation with or without dispatcher instructions in family- and non-family-witnessed cardiopulmonary arrests. Chi-square tests were conducted to evaluate differences between cases with dispatcher instructions and those without.

Fig. 3: Adjusted odds ratios and 95% confidence intervals on multivariate logistic regression analysis for the provision of bystander CPR (A) and neurologically favorable survival (B) in patients with bystander-witnessed and non-traumatic out-of-hospital cardiopulmonary arrest.

Table

Table 1　Characteristics of patients with cardiopulmonary arrest witnessed by citizens.

	Overall (n=559)	Family-witnessed (n=414)	Non-family-witnessed (n=145)	*P* value
Age, median (IQR), y	76 (65, 85)	76 (66, 84)	79 (59, 88)	0.736
Male sex, n (%)	362 (64.8)	273 (65.9)	89 (61.4)	0.322
Dispatcher instruction, n (%)	298 (53.3)	226 (54.6)	72 (49.7)	0.305
Bystander CPR, n (%)	231 (41.3)	142 (34.2)	89 (61.4)	<0.001
Rescue breathing only	4 (1.7)	4 (2.8)	0 (0.0)	
Chest compression only	135 (58.4)	97 (68.3)	38 (42.7)	
Conventional CPR	82 (35.5)	41 (28.9)	41 (46.1)	
AED	10 (4.3)	0 (0.0)	10 (11.2)	
Cardiac origin, n (%)	412 (73.7)	302 (72.9)	110 (75.9)	0.493
VF or pVT on EMS arrival, n (%)	118 (21.1)	73 (17.6)	45 (31.0)	0.001
Defibrillation by EMS, n (%)	144 (25.8)	93 (22.5)	51 (35.2)	0.003
Outcomes				
1-month survival, n (%)	38 (6.8)	23 (5.6)	15 (10.3)	0.049
Neurologically favorable survival, n (%)	26 (4.7)	14 (3.4)	12 (8.3)	0.016
Time intervals, median (IQR), min				
Call to CPR by EMS	8 (7, 10)	9 (7, 10)	8 (7, 11)	0.889
Call to hospital arrival	29 (24, 36)	29.5 (25, 36)	28 (23, 34.5)	0.066

Statistical differences between family- and non-family-witnessed OHCA were evaluated. *P*-values were calculated using the Mann-Whitney U test for continuous variables or the chi-square test for categorical variables.

CPR: cardiopulmonary resuscitation; AED: automated external defibrillator; VF: ventricular fibrillation; pVT: pulseless ventricular tachycardia; EMS: emergency medical services; IQR: interquartile range.

Table 2　Neurologically favorable survival rates of patients with witnessed cardiopulmonary arrest.

		Overall	Bystander CPR	
			Yes	No
Witnessed		4.7 (26/559)	6.5 (15/231)	3.4 (11/328)
Family-witnessed		3.4 (14/414)	3.5 (5/142)	3.3 (9/272)
Dispatcher instruction	Yes	3.5 (8/226)	3.2 (4/125)	4.0 (4/101)
	No	3.2 (6/188)	5.9 (1/17)	2.9 (5/171)
Non-family-witnessed		8.3 (12/145)*	11.2 (10/89)*	3.6 (2/56)
Dispatcher instruction	Yes	8.3 (6/72)	10.5 (6/57)*	0.0 (0/15)
	No	8.2 (6/73)	12.5 (4/32)	4.9 (2/41)

Numbers show the rates of neurologically favorable survival (%) and, in parentheses, the number of survivors per patient categories. *: $P<0.050$ vs. family-witnessed.

Figure 1
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Fig.1

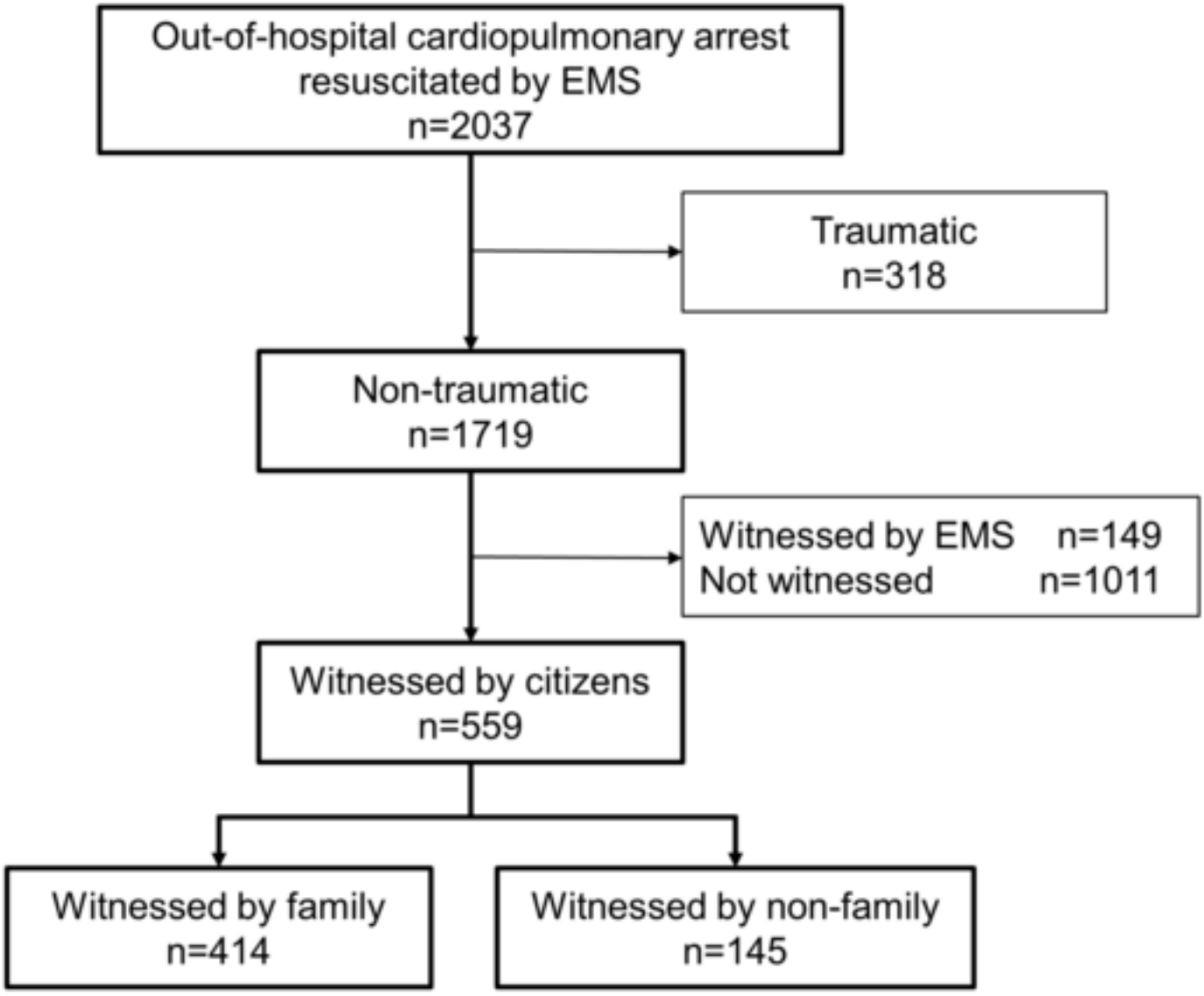

Figure 2
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Fig.2

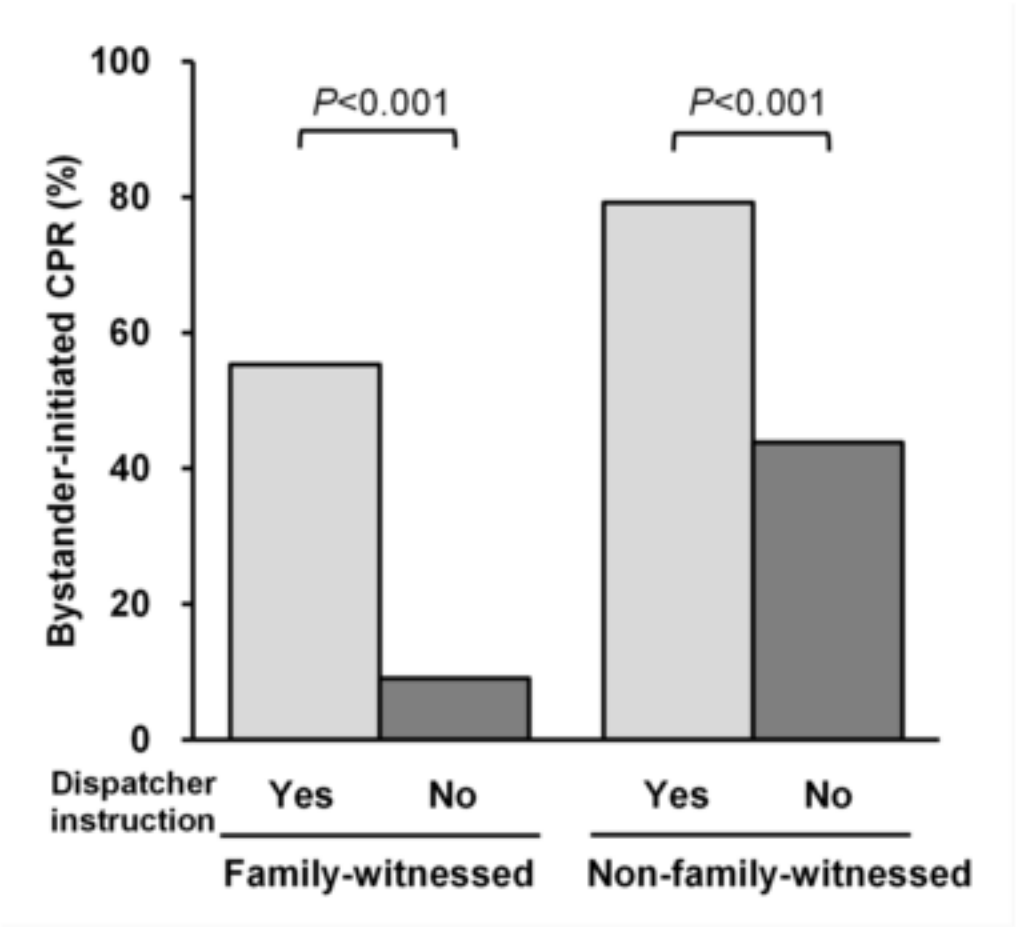

Figure 3
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Fig.3